DOCUMENT RESUME

ED 230 394 SE 041 594

AUTHOR Tsai, Shiow-Ling; Walberg, Herbert J.
TITLE Mathematics Achievement and Attitude Productivity in Junior High School.
PUB DATE 83
NOTE 19p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Attitudes; *Educational Assessment; Educational Research; Factor Analysis; Junior High School Students; *Mathematics Achievement; Secondary Education; *Secondary School Mathematics; *Student Characteristics; Testing
IDENTIFIERS Mathematics Education Research; National Assessment of Educational Progress

ABSTRACT

To investigate the dependence of mathematics achievement and attitudes on each other and other factors, achievement test scores and ratings of 2,368 13-year-old students who participated in the 1977-78 National Assessment of Education Progress (NAEP) were analyzed. Achievement was significantly associated with attitudes, sex, ethnicity, father's and mother's education, verbal opportunities in the home, and frequency of mathematical practices when the variables were statistically controlled for one another. Constructive mathematics attitudes were associated with achievement and the same factors except parent education. About 32 percent of the achievement variance and 8 percent of the attitude variance can be accounted for by the factors. (Author)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED230394

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Mathematics Achievement and Attitude Productivity in Junior High School

Shiow-Ling Tsai and Herbert J. Walberg

University of Illinois at Chicago

Running Head: Achievement and Attitude

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Shiow-Ling Tsai
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE041594

Abstract

To investigate the dependence of mathematics achievement and attitudes on each other and other factors, achievement test scores and ratings of 2,368 13-year-old students who participated in the 1977-78 National Assessment of Education Progress (NAEP) were analyzed. Achievement was significantly associated with attitudes, sex, ethnicity, father's and mother's education, verbal opportunities in the home, and frequency of mathematical practices when the variables were statistically controlled for one another. Constructive mathematics attitudes were associated with achievement and the same factors except parent education. About 32 percent of the achievement variance and 8 percent of the attitude variance can be accounted for by the factors.

Mathematics Achievement and Attitude as Functions of One Another and Other Factors

For the past two decades, research workers have tried to identify productive factors that influence cognitive achievement and affective attitudes as educational outcomes. Although reviews of large-scale input-output surveys of distal and proxy measures indicate only small and somewhat inconsistent influences (Bridge, Judd, and Moock, 1979), syntheses of experimental and smaller-scale but better instrumented surveys reveal a considerable number of consistent moderate to large effects (Walberg and Haertel, 1980). The productivity factors most closely connected with learning may be divided into nine categories: student age, ability, and motivation; amount and quality of instruction; and the psychological environments of the home, school, and peer-group outside the school; and exposure to mass media, particularly television (Walberg, 1981). Moreover, recent analyses of high school survey data in mathematics and science collected by the National Assessment of Educational Progress (NAEP) show that these factors, even when measures of them are obtained by relatively few student-questionnaire items, are significant influences on learning when controlled for one another in multiple regressions and that they account for considerable variance in mathematics and science achievement among high school students (Welch, Anderson, and Harris, 1982; Walberg, Pascarella, Haertel, Junker, and Boulanger, 1981).

Thus, analysis of NAEP data can complement syntheses of intensive studies that generally manipulate or merely observe one or two factors in that the multivariate influences of each of the factors, controlled for more complete sets of the other factors, can be simultaneously investigated. The purpose of the present study is to extend the analysis of NAEP data to the case of mathematics learning among 13-year-olds even though the factors represented are

fewer in number and less well measured than in the studies of mathematics among 17-year-olds and science among 13-year-olds.

Method

Sampling

The data were obtained on a sample of 2,368 13-year-old students who participated in the National Assessment of Educational Progress (NAEP) in 1977-1978 by completing Booklet 9. NAEP employed a multistage sampling design with oversampling of low-income and rural areas (NAEP, 1979). In the first stage, the United States was divided into primary sampling units (PSU's) some of which, low income and rural, were over-sampled to insured sufficient representation for special estimates. In the second stage, public and private schools were randomly selected within PSU. In the third stage, age-eligible students (born during calender year 1964) were randomly sampled within each school.

Variables and Sample Characteristics

Table 1 defines the variables and shows, when appropriate, internal-consistency reliablities, paraphrased item examples, and scoring keys as well as the percentage of the 2,368 students in each category of the qualitative variables. The dependent variables are achievement and attitude. The achievement test included 74 mathematics achievement items with a high internal-consistency reliability, .92. The achievement test covers five areas: numbers and numeration; variables and relationships; geometry; shape, size and position; and measurment and other topics.

Fourteen mathematics attitude items concern the student self concept as a mathematician and favorable opinions of mathematics; the items form a summed scale with low reliability, .25. Although the scale shows low intenal consis-

tency, it turned out to be a valid and significant predictor of achievement; the lack of internal coherence may indicate that the scale taps many, slightly related aspects of mathematics attitude.

Among the independent variables, experience (see Table 1) indicates how often students used the metric system of measurement and hand calculators in or outside of school; since the scale has a particularly low internal consistency, .16, the items were analyzed separately in some analyses.

Father's and mother's education shows the highest amount of father's and mother's education and serves as proxy indicators of ability. The four items available to measure home-environment stimulus materials form a scale with a reliability of .44. Although sex and ethnicity are not productivity constructs, they are included in the analysis as possibly useful covariates and to examine their association with outcomes since prior research shows their consistent influence on mathematics achievement (see, for example, Fennema's, 1977, review). Boys and girls, whites, blacks, Hispanics, and others are represented in the sample, as Table 1 shows, in proportions approximating their percentages of population of the U.S.

It was recognized before and during the analysis of the items and their reliabilities that relatively few productivity constructs are represented in the data set and that those that are represented are poorly measured compared to prior casual analyses of NAEP data. Thirteen-year-olds, moreover, have a more limited perspective than 17-year-old in rating instruction and other aspects of their schools. Whether or not the variables relate to achievement is an empirical question, however, one that it well worth exploring to determine the generalizability of the findings to other age levels and subjects notwithstanding the measurement problems.

Results and Discussion

Univariate Results

Table 2 shows the frequency distribution of each independent variable and the means, standard deviations, and F-tests for student's achievement and attitude as related to each factor. All of the factors make for significant differences in achievement. Spreads of a full standard deviation of achievement (about 11 points) across categories of ethnicity, both parent's education, magazines received, books and encyclopedias in the home, and attitude can be seen. Sex, mathematics experiences, and newspaper subscriptions are significant but are associated with small differences in achievement.

Attitude, even though the scale is of low internal consistency, is also significantly associated with seven factors. For example, the education of the father and mother and the presence of reading materials in the home are significantly related to mathematics attitude.

Multivariate Results

Table 3 shows that, when the factors are controlled for one another in multiple regressions (or more correctly, in "general linear models," since the qualitative factors enter as sets of binary-coded factor categories, (SAS, 1979), they all remain significant for achievement and account for 32 percent of the variance, in contrast to the 59 percent accounted for in high school mathematics and 31.5 percent accounted for in junior high school science. (Welch, Anderson, and Harris, 1982; Walberg, Pascarella, Haertel, Junker, and Boulanger, 1981). The variance accounted in mathematics attitude is only 8 percent and is insignificant at the conventional .05 level, although ethnicity, experience, and achievement are significant as factors when controlled for one another and the other factors.

In addition to these analyses, the first-order interactions among the factors were generated and statistically assessed. The set of interactions are insignificant, however, and there is no indication that mathematical experience and home environment are especially helpful to any subgroups of students or that the factors interact in other ways.

Mathematical Experiences and Outcomes

Since the experience scale was internally inconsistent, as noted above, the correlations of the individual items, with achievement and attitude uncontrolled (r) and controlled (r_p) for each other and the other factors, were also calculated. Table 4 shows the interesting results. Achievement is correlated positively with the reported possession, but negatively with the frequent use, of a hand calculator. Achievement is correlated positively with reported use of the metric system in science classes but negatively with use in other classes and use outside of school. Mathematics attitude is correlated positively with the use of the metric system in mathematics classes but negatively with its outside of school. Thus it appears that some experiences are positive and others are negative predictors of general mathematics achievement.

Conclusion

Although a significant variance in achievement can be accounted for by student background characteristics and experiences, niether the set as a whole nor specific factors are as closely correlated in the present sample of 13-year-olds as they are in the previous study of mathematics achievement in a NAEP sample of 17-year-olds (Welch, Anderson, and Harris, 1982). The reasons seem clear: quality and quantity of mathematics achievement, and peer-group and classroom environments are unrepresented in the present data; the other

productive constructs that are represented are less reliably measured; and 13-year olds may have a more limited frame of reference in rating their educational experiences and attitudes. Nonetheless, all the factors represented proved significant when controlled for one another and socioeconomic status and ethnicity; and the findings for the present sample foreshadow those on older adolescents in mathematics and corroborate those found in the case of 13-year-olds in science (Walberg, Pascarella, Haertel, Junker, and Boulanger, 1981).

Certain educational implications seem clear. The family background of the student is decisive in learning, even in the subject of mathematics which may appear to be learned exclusively in school. The intellectual stimulation afforded by parents of higher education together with verbal materials such as books and magazines are condusive not only to reading but to mathematics achievement as well. Since about 85 percent of the student's waking, potentially-educative hours between birth and age 18 are at least nominally controlled by parents rather than educators, the home is a critical influence on the amount learned. To the extent that educators and parents can cooperate to increase the stimulating or supportive conditions in the home, achievement is likely to rise proportionately.

In addition, mathematics attitude is also influenced by home conditions and achievement. Causality, however, may be reciprocal: the more one learns, the higher the attitude; and the higher the attitude, the greater one learns. Inproving attitude and encouraging greater learning are both important for long-term results.

References

Bridge, R.G., Judd, C.M., and Moock, P.R. The Determinants of Educational Outcomes, Cambridge, Massachusetts: Ballinger, 1979.

Fennema, E. Influences of selected cognitive, affective, and educational variables on sex-related differences in mathematics learning and studying, in Women and Mathematics, Washington: National Institute of Education, 1977.

National Assessment of Educational Progress, Three Assessments of Science, 1969-77: Technical Summary (Report No. 08-5-21). Denver: Education Commission of the States, 1979.

SAS User's Guide, Raleigh, North Carolina: SAS Institute, 1979.

Walberg, H.J. A theory of educational productivity in H. Farley and N. Gordon (Eds.) Psychology and Education, Berkeley: McCutchan, 1981.

Walberg, H.J., and Haertel, E. (Eds.), Quantitative Research Synthesis, A special issue of Evaluation in Education, 1980, 4, 1-144.

Walberg, H.J., Pascarella, E., Haertel, G.D., Junker, L., and Boulanger, F.D. Probing a model of education productivity with National Assessment samples of early adolescents. American Educational Research Journal, 1981, 18, 233-249.

Welch, W.W., Anderson, R.E., and Harris, L.J. The effects of schooling on mathematics achievement. American Educational Research Journal, 1982, 19, 145-153.

Table 1

Variable Description and Sample Characteristics

Variable	Paraphrased sample items, Scoring, Percent of sample in each category when applicable based on 2,368 students
Achievement	74 mathematics achievement items Alpha internal consistency reliability=.92 "Which of the following is true about 112% of 12? a) It's greater than 12 (correct) b) It's less than 12 c) It's equal to 12 d) Can't tell e) I don't know" "A school bus holds 36 students. If 1128 students are being bused to the camping area, how many buses are needed? Answer 12 " "To add 3+7+8 you can add 3 & 7 and then add this sum to 8, or you can first add 7 & 8 and then add 3 to this sum. Which one of the following expresses this idea? a) a+b+c=d b) a+b+c=abc c) (a+b)+c=(b+a)+c d) (a+b)+c=a+(b+c) (correct) e) I don't know Coded: correct=1, incorrect=0
Attitude	14 attitude items toward mathematics Alpha internal consistency reliability=.25 "I am good at mathematics."

Table 1 (continued)

(Attitude)	"I would like to take more mathematics." "It's important to know mathematics in order to get a good job." "Mathematics helps a person to think logically." Strongly Disagree...Disagree...Undecided...Agree...Strongly Agree
Experience	8 items asking about experience in mathematics Alpha internal consistency reliability=.16 "The metric system if measurement uses units like centimeters, liters, and kilograms. How often have you used the metric system? Often...Seldom...Never...I don't know (reverse coded) "How often do you use a calculator? Almost Daily...A Few Times a Week...Less Than Once a Week...Once a Month " "How often have you used the metric system of measurement in each of the following: a) In math classes b) In science classes c) In other classes in school d) Outside of school Never...Seldom...Often...I don't know
Sex	Coding 1=male (51.9%) 2=female (48.1%)

Table 1 (continued)

Race/Ethnicity	Dichotomous categories for each of the following: White (79.31%) Black (14.32%) Hispanic (5.57%) Native American (.17%) Asian, Pacific Islander (.08%)
Home	4 items on home characteristics Alpha internal consistency reliability=.44 "Is there an encyclopedia in your home?" "Does your family get a newspaper regularly?" "Does your family get a magazine regularly?" "Are there more than 25 books in your home?" Scoring: 0 = No 1 = Yes
Father's Education	Highest amount of father's education Coding: 1 - Less than 8th grade (3.8%) 2 - No high school (4.6%) 3 - Some high school (7.3%) 4 - Graduated from high school (27.5%) 5 - Post high school (33.6%)
Mother's Education	Highest amount of mother's education Coding: 1 - Less than 8th grade (2.7%) 2 - No high school (4.4%) 3 - Some high school (9.8%) 4 - Graduated from high school (36.6%) 5 - Post high school (28.0%)

Table 2

Analysis of Variance of Achievement and Attitude

	Achievement					Attitude				
Variable	Percent	N	Mean	Standard Deviation	F	Percent	N	Mean	Standard Deviation	F
Sex										
Male	52	1206	40.57	12.38	5.42*	52	1031	9.71	2.35	.87
Female	48	1117	41.72	11.31		46	946	9.60	2.50	
Ethnicity										
White	79	1840	43.64	10.94	99.08**	80	1582	9.69	2.53	1.96
Black	14	335	30.59	10.20		14	272	9.65	2.39	
Hispanic	6	130	32.95	10.31		5	105	9.22	2.63	
Asian and Pacific Islanders	1	12	40.33	11.69		1	12	8.75	2.93	
Father's Education										
Less than 8th grade	5	88	34.95	10.28	55.82**	5	72	9.57	2.44	6.68*
No high school	6	104	38.85	10.25		6	89	9.47	2.59	
Some high school	9	170	38.14	10.85		9	140	9.49	2.53	
Graduated from high school	36	641	41.55	10.08		36	549	9.59	2.43	
Post high school	44	782	47.05	11.28		44	679	10.21	2.45	
Mother's Education										
Less than 8th grade	3	62	33.39	10.29	54.06**	3	44	9.48	2.36	5.30*
No high school	5	103	34.57	9.67		5	84	9.39	2.70	
Some high school	12	227	38.85	10.89		12	197	9.79	2.38	
Graduated from high school	45	851	42.49	10.56		45	728	9.63	2.50	
Post high school	35	654	46.55	11.31		35	570	10.21	2.49	
Newspaper Received Regularly										
Yes	84	1899	42.32	11.73	77.13**	84	1622	9.77	2.51	16.34**
No	16	371	36.53	11.04		16	309	9.14	2.56	
Magazine Received Regularly										
Yes	72	1641	46.63	11.23	239.64**	73	1403	9.89	2.48	41.83**
No	28	629	35.47	11.26		27	528	9.07	2.55	

Table 2 (continued)

Variable	Achievement Percent	N	Mean	Standard Deviation	F	Attitude Percent	N	Mean	Standard Deviation	F
More Than 25 Books at Home										
Yes	94	2126	42.11	11.51	139.73**	94	1813	9.72	2.51	11.16**
No	6	144	30.44	10.84		6	118	8.92	2.75	
Have Encyclopedia at Home										
Yes	83	1883	42.03	11.65	34.66**	83	1612	9.72	2.51	3.73
No	17	387	38.18	12.09		17	319	9.42	2.59	
Experience[b]										
0	11	248	36.49	10.87	12.29**	11	205	9.20	2.49	5.92*
1	31	717	40.84	11.24		31	596	9.59	2.53	
2	28	652	41.90	11.56		28	546	9.54	2.52	
3	19	445	42.45	12.26		19	374	9.89	2.41	
4 or more	11	261	42.10	13.62		11	220	10.24	2.52	
Attitude Percentile										
0- 22	12	223	35.91	12.48	47.76**					
23- 40	25	486	38.35	11.22						
41- 60	19	374	41.18	11.65						
61- 80	18	358	42.53	11.25						
81-100	26	496	46.59	11.21						
Achievement Percentile										
0- 25						25	494	8.81	2.49	47.53**
26- 50						24	477	9.38	2.51	
51- 75						25	495	9.78	2.36	
76-100						26	511	10.60	2.39	

NOTE: F-tests significant at .05 and .01 are indicated respectively with one and two asterisks. The numbers of cases vary somewhat since not all students answered all items.

[b]Experience is the sum of the items as coded in Table 4.

Table 3

F-Values and R^2 for Achievement and Attitude Regressions

Achievement	F-Value	R^2
Sex	5.83**	.323***
Ethnicity	84.68***	
Father's education	11.17***	
Mother's education	6.96***	
Home Environment	10.46***	
Experience	1.98*	
Attitude	24.89**	

Attitude	F-Value	R^2
Sex	3.20*	.082*
Ethnicity	3.36**	
Father's education	.17	
Mother's education	1.53	
Home Environment	2.34*	
Experience	2.48**	
Achievement	25.62**	

NOTE: * = $\alpha < .10$
** = $\alpha < .05$
*** = $\alpha < .01$

Table 4

Partial Correlations of Metric and Calculator Experience with Mathematics Achievement and Attitude

Variable	Achievement r	Achievement r_p	Attitude r	Attitude r_p
How often have you used the metric system?				
Often=1, Other=0	.03	.01	.09**	.11**
How often have you used a hand calculator?				
Often=1, Other=0	-.05*	-.06*	-.00	-.01
Do you own a hand calculator?				
Yes=1, No=0	.18**	.07**	.04	.00
Does your school provide hand calculators?				
Yes=1, No=0	-.02	.01	-.02	.00
How often have you used the metric system of measurement in				
Math classes: Often=1, Other=0	.03	.00	.10**	.10**
Science classes: Often=1, Other=0	.22**	.18**	.09**	.02
Other classes in school: Often=1, Other=0	-.14**	-.08**	-.05*	-.03
Outside of school: Often=1, Other=0	-.07**	-.07*	.04	.06*

Note: The symbols r and r_p indicate respectively simple and partial correlations.

*=α<.05
**=α<.01